CS 4331/MATH 4000 – Special Topics:
High Performance Computing
Summer I 2012

Lecture Time:    Monday through Friday, 10 a.m. – 11:50 a.m., June 5th – July 3rd
Lecture Location:  Engineering Center 201, June 5th – June 26th
                 PETR 118, June 27th – July 3rd
Sessions and CRNs:  CS4331-001 CRN: 30796
                 MATH4000-103 CRN: 34091

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1. Course Description

High performance computing (HPC) technologies have been widely used in scientific
discovery and innovations, such as climate modeling and weather forecasting, molecular
dynamics simulation, high-energy physics, computational biology, and geographical
information systems. This course introduces the principles, systems, programming, and
applications of high performance computing. Students are expected to learn the principles
and gain hands-on experience in high performance computing. This course will also train
students to be ready to compete in the well-known Student Cluster Competition at the
International Conference for High Performance Computing, Networking, Storage and
Analysis (a.k.a Supercomputing conference) and introduce students to the high
performance computing community.

2. Course Goals

- Goal 1: for students to understand the needs of parallel computing and high
  performance computing
- Goal 2: for students to learn parallel computer architectures, performance metrics,
  and evaluations
- Goal 3: for students to understand parallel programming models and parallel
  algorithms design
- Goal 4: for students to learn cluster design, deployment, and operation process
- Goal 5: for students to gain hands on experience with parallel computing and high
  performance computing
3. Textbooks

There are no required textbooks for this course. There are three reference books that might help you understand the fundamentals of high performance computing:

- *Introduction to High Performance Computing for Scientists and Engineers*
  By Georg Hager and Gerhard Wellein
  Publisher: CRC Press
  ISBN-10: 143981192X

- *Using MPI: Portable Parallel Programming with the Message-Passing Interface*
  By William Gropp, Ewing L. Lusk, Anthony Skjellum
  Publisher: The MIT Press; 2nd edition
  ISBN-10: 026257134X

- *Building Clustered Linux Systems*
  By Robert W. Lucke
  Publisher: Prentice Hall
  ISBN-10: 0131448536

4. Prerequisites

Knowledge of the following topics is recommended:
- Operating Systems, Unix (Linux, OS X) experience
- Computer Architectures
- Programming (C/C++)

5. Detailed Course Topics and Schedule

- 6/5, Highlights of course syllabus, introduction to parallel computing, high performance computing, and other computing paradigms
- 6/6, Parallel computer architectures
- 6/7, Parallel performance, metrics, and evaluation
- 6/8, Message passing parallel programming
- 6/11, Message passing parallel programming
- 6/12, Parallel algorithms design
- 6/13, Programming massively parallel processors on GPU
- 6/14, Cluster design, deployment, and operations
- 6/15-6/26, Students presentations on selected topics: scientific applications, hardware configurations, energy-efficient high performance computing, and storage techniques
• 6/27-7/3, Cluster interactions and hands-on experience with parallel computing and high performance computing, open discussions

6. Computer Usage

The on-campus High Performance Computing Center (HPCC) facility including a 640-node cluster, namely Hrothgar cluster, and local cluster test bed will be used for assignments and hands-on experience projects. Detailed information regarding the access will be announced. The last week of hands-on experience will be carried out in the PETR 118 computer lab room with computer access.

7. Expected Course Learning Outcomes and Methods of Assessment

The student is expected to demonstrate competence in these course-level learning objectives via class participation, after-class independent study, group research and presentations, and cluster interaction. These are cross-referenced to the Program Level Outcomes and Assessment of Bachelor of Sciences Degree in Computer Science (denoted as BSCS.x).

<table>
<thead>
<tr>
<th>Learning Outcome</th>
<th>Method of Assessment</th>
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<tbody>
<tr>
<td>Understand the needs and importance of high performance computing (BSCS.3)</td>
<td>Tests and group research</td>
</tr>
<tr>
<td>Understand the principles of parallel computer architectures, performance metrics and evaluations (BSCS.1, BSCS.3)</td>
<td>Tests and cluster interaction</td>
</tr>
<tr>
<td>Understand parallel programming models and algorithms design (BSCS.2)</td>
<td>Tests, group research, and cluster interaction</td>
</tr>
<tr>
<td>Understand cluster design, deployment, and operation process (BSCS.3)</td>
<td>Cluster interaction</td>
</tr>
<tr>
<td>Be able to conduct open research study on selected topics (BSCS.2, BSCS.4, BSCS.5, BSCS.7)</td>
<td>Group research</td>
</tr>
<tr>
<td>Be able to make a formal presentation on a technical topic and write up a formal report on a technical topic (BSCS.4, BSCS.5, BSCS.7)</td>
<td>Group research, presentation, and report writing</td>
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8. Grading Policy

All submissions are graded according to the assignment guidelines, course policies, verbal instructions/explanation and materials given in class lecture or in meetings, quality, creativity, novelty, readability and level of effort.

• Take-home tests – 20%
• Group research, presentations, and reports – 30%
• Group interaction with clusters – 30%
• Attendance – 20%

9. Course Letter Grade Assignments
- A = 90-100
- B = 80-89
- C = 70-79
- D = 60-69
- F <= 59

10. Course Policies:

10.1. Code of Student Conduct:

Students are expected to comply with the Texas Tech Code of Student Conduct in all aspects of this class. The Code of Student Conduct may be found at [http://www.depts.ttu.edu/dos/docs/Student%20Handbook%202011-2012.pdf](http://www.depts.ttu.edu/dos/docs/Student%20Handbook%202011-2012.pdf).

In order to assure that all students have the opportunity to gain from time spent in class, unless otherwise approved by the instructor, students are prohibited from engaging in any other form of distraction, such as reading newspapers, working on other classes, taking cell phone calls, and working on laptop computers. Inappropriate behavior in the classroom shall result, minimally, in a request to leave class.

Violations of conduct including academic dishonesty, foul language, and classroom citizenship are eligible to be reported to [Student Judicial Services](http://www.depts.ttu.edu/dos/docs/Student%20Handbook%202011-2012.pdf).

10.2. Attendance:

Attendance is mandatory for all lectures. Roll will be taken randomly. One point will be deducted for each unexcused absence.

10.3. Absence due to religious observance:

The Texas Tech University Catalog states that a student may be excused from attending classes or other required activities, including examinations, for the observance of a religious holy day, including travel for that purpose. A student whose absence is excused for this purpose may not be penalized for that absence and shall be allowed to take an examination or complete an assignment from which the student is excused. (see p.51)

10.4. Absence due to officially approved trips:

The Texas Tech University Catalog states that the person responsible for a student missing class due to a trip should notify the instructor of the departure and return schedule in advance of the trip. The student may not be penalized and is responsible for the material missed. (see p.50)

10.5. Late Work:
Assignments are due when specified, but will be accepted late (with a 10-20% penalty) until graded work is returned. If you know you will be absent ahead of time, turn your assignment in early.

10.6. Accommodations:

The university is committed to the principle that in no aspect of its programs, shall there be differences in the treatment of persons because of race, creed, national origin, age, sex, or disability and that equal opportunity and access to facilities shall be available to all. If you require special accommodations in order to participate, please contact the instructor during office hours or by e-mail yong.chen@ttu.edu. Students should present appropriate verification from Student Disability Services. No requirement exists that accommodations be made prior to completion of this approved university process.